

Science Policy and Globalization

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My question, for this short presentation, is what kind of science policy, if any, is possible and makes sense today for countries that lay outside the mainstream of scientific production, be they *transition*, *newly industrializing* or *emergent* societies.

To answer this question, one needs to consider at least three very broad tendencies that are typical of today, but used to be very different in the recent past.

The first is that most governments in these countries are facing the need to reduce public spending and to increase support for social and environment protection programs, and do not have enough to invest in ambitious science and technology projects. Even when resources are available, the notion that science and technology activities, because they are public goods, should be fully or almost fully subsidized by governments, is becoming very difficult to sustain.

The second is that the new technologies of information and the intensification of international trade and foreign direct investments by multinational firms are leading to the breakdown of communication barriers which existed among countries and their technical and scientific communities. This may be seen as a positive trend, since it makes international, state of the art know-how much more readily accessible than in the past. But it can also have negative effects, since it can destroy incipient scientific and technological communities and projects that cannot resist the competition of foreign knowledge producers.

The third are the changes in speed and in the very nature of knowledge producing systems throughout the world. The two main modes for scientific and technological development, followed by developed countries and copied in the South, were basic research in academic institutions, and high technology projects, usually military, both supported by governments. This combination of *free* research, guided supposedly by the intellectual curiosity of the researchers, and a large sector of applied, military oriented research, may seem incongruent at first glance, but was typical of leading scientific countries such as the US, France, England

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and Israel, and emulated by developing countries such as India and Brazil. Today, the intellectual, institutional and financial demarcations between basic, or academic, and applied research have almost vanished, and the large-scale, high technology, national prestige projects are disappearing, and being replaced by company-based, product oriented research of different kinds.

Countries that, in the past, have made significant investments in the traditional modes of scientific and technological production, trying to develop isolated, or *enclave* scientific communities or, more seriously, ambitious projects of technological self-sufficiency, may find themselves now in a difficult position. They may have large, unfinished projects claimed by well-articulated and influential groups, and a frustrated academic community complaining about dwindling resources and opportunities. They risk to keep spending money and resources to maintain these projects alive and these communities satisfied, without being able to achieve either. They run also the opposite risk, which is to destroy whatever research competence they may have developed in the past, in the name of globalization, competitiveness and the market logic. Their challenge is to convert these institutional and intellectual assets into something useful and adjusted to the modern times, without having to start again from scratch.

Japan, and more recently South Korea, have been heralded as representing a better and more satisfying model to follow. They seem to have adopted the so-called *reverse sequence* of scientific development. Instead of starting with basic research, from which applied knowledge and development work would follow, they started with product innovation and applied work, from which they built their competence in more complex technologies and basic science. They did not invest much on basic science, and did not rely on high technology projects as the source from which technological prowess would trickle down to the economy as a whole. Instead, they started with the production of simple consumption goods, relying on efficient management and cheap labor to compete with the best products of mature economies, and slowly climbed their ways to the production of knowledge-intensive products; they did not try to reinvent the wheel, but copied whatever they could from more advanced economies and societies.

One wonders, and not just because of the recent crisis in the Asian economies, whether this road is still open for other countries willing to follow the same path. As Japan, and later Korea, became richer, the cost of their labor increased, and the production of technologically intensive commodities for the world markets moved to previously unsuspected countries and regions, such as Malaysia, the Philippines, Thailand, the *maquiladora* plants in the US-Mexican border, Manaus, by the Amazon River, and mainland China. It is not clear how Japan and Korea will come out of the current crisis, but it is certain that will not go back to the low levels of scientific and technological competence of before their years of intense development and growth. What is uncertain, however, is whether the countries that now produce the technology intensive production goods, usually under license and contracts from large multinationals from Asia or the US, will be able to repeat the Japanese and Korean path.

There are two reasons for this doubt. One is that these *new* countries are not finding their own way for new and competitive products, as Japan and Korea did, but simply providing cheap and docile labor to perform

routine, pre-defined tasks allotted to them. One wonders about what kind of learning-by-doing, if any, they are able to achieve. The second, and more serious reason to doubt, is that both Japan and Korea preceded their drive for industrial and technological growth by heavy investment in the education of their population, things the new Asian tigers and their imitators did not do, at least not on the same scale.

These doubts do not mean that one should give up trying to link science and technology with industry, only that we should look deeper on the ways these linkages take place. Innovation occurs in all kinds of activities, from the introduction of new products and processes to incremental improvements and management changes. Governments have a role to play in identifying institutional arrangements and incentives more conducive to stimulate innovation. The provision skills (that is, education), free flow of information, and a competitive environment are more important, in terms of policy, than to try to foster specific technologies. To say that education should be the priority, not research, is not to say that researchers should stop doing research and become teachers (although many of them should). It is to say that, If one has a broad and good quality educational environment, it provides a basis for good scholarship, academic and applied research on top of it. Without this basis, however, research can do very little.

Governments can also play a very important role as one of the most important, if not the main client for research in a country, in replacement of the old tradition of supporting military research. Problems related with the environment, natural resources, social issues related to health, education and sanitation, urban planning, energy conservation, water administration, all these questions, which will become higher and higher in the public agenda, require intense research and technology, which can be bought from academic institutions. Such a policy would require governments to work with different ministries and local governments to increase their procurement capabilities and provide them with resources to "buy" research, instead of giving resources directly to the research councils and institutions.

The importance of investing in good quality education, rather than in technological or even scientific products, can be seen very easily if we think on the ways the products of scientific and technological knowledge can be appropriated. In the past, the prevailing notion was that technology was some kind of secret kept under wraps by companies and governments, which could only be open by heavy investments and reverse engineering, often done also in secrecy. There are still military secrets, of course, and high technology firms work hard to keep control of the technology hidden in their products. Now, however, technological processes, instruments, products and training are being bought and sold in the international markets as commodities; innovative products and processes are short-lived, being rapidly replaced by competing products; and open, scientific knowledge is disseminated almost instantaneously, regardless of its places of production and acquisition. For all these reasons, it is very difficult to keep control and reap the benefits of technology intensive products or even scientific breakthroughs, except by an endless run at the technological frontiers, to keep some inches ahead of the competition. What Microsoft sells is not so much the secrets of Windows, but its ability to come up with a new Windows every two or three years. In other words, it sells "innovation" as such, more than the new product. The same holds for cars: the

successful manufacturer is not the one who makes the best car ("everybody" can make a good car today), but the one who can launch an innovative model each year. The name of the game in research and development is not just to find the answer to specific problems, or to "discover" or "invent" things, but the ability to be creative and innovative, of borrowing, buying and finding alternative ways of doing new things all the time.

At the bottom, the way to keep control and reap the benefits of scientific and technological knowledge is not by the appropriation of technological products and artifacts, be they physical or intellectual, but by the development of the ability to absorb the existing knowledge, to create new things, or to put old things to better use. For this, what matters most is not the explicit knowledge products, but the implicit and tacit knowledge embodied in the heads and daily practices of educated populations. If this is so, science policy for the twenty first century, not only for countries in the South, but for everybody, should be in essence policies for education, dissemination, networking and communication, rather than policies for the development of specific products, the protection of specific firms and institutions, or the recreation of isolated, self-contained scientific communities.

The main difficulty with this proposition is that, as communication becomes cheaper and more efficient, the trend for concentration of resources and capabilities, which have always been typical of scientific and technological research, intensifies. Concentration takes place not only in some countries, but also in some regions within countries, the well-known poles of high technology, heralded by the example of Silicon Valley. But it is also true that the flow of communication and interchange, because it is so cheap, is in principle open to whoever has the necessary skills and the language to join in the conversation. Innovation takes place not only in very large institutions with multimillion dollar budgets and thousands of employees, but along a very large spectrum of sizes and investment capabilities. It occurs in the US and Germany, but can also take place in Norway or Finland. This is why high quality education, support for international cooperation and interchange, easy access to information and to advanced instrumentation are the essential foundations of any successful science policy. Good quality education is expensive, and is likely to remain so; communication, access to information and use of sophisticated instruments are getting cheaper and more accessible each day, and can be used to spread the access and benefits of education as well. The best use a country can make if its existing academic competence is to use it as much as possible to increase the quality of its educational institutions and its ability to link and participate in the international flux of technological resources and knowledge. This strategy can make much more sense than to require from all scientists and researchers to find partners in the private sector, and come up with marketable patents, products and processes.

Another important policy conclusion is the need to stimulate, preserve and maintain places where skills and competence can come together, coalesce and develop the social fabric for innovation and entrepreneurship. This means that, even if we move away from big and expensive projects, we cannot avoid concentrating resources in some places and regions, more than in others. Life is not just work and competition. It is also

enjoyment, conviviality and pleasant lifestyles. Successful science and technology poles are those that combine, in the same region, good universities, easy access, effective communications, and a pleasant urban and natural environment.

There is nothing new on this idea, except that it seldom appears explicitly in the governments' statements and proposals for scientific and technological development. There is a good reason for that. Public policies are supposed to be equitable, but the development of high quality, socially dense and pleasant communities leads to the intensification of differences. One way to compensate for that is to decentralize, making the development of local competence as dependent as possible on local initiatives and resources. The other is to understand that the social benefits of investments in science and technology cannot be gauged by the way the investments are spread out, but by the way the benefits accruing from high quality and highly productive environments can be useful for all. It is a difficult path to thread, between equity and the concentration of benefits and privileges, without which, however, no successful science policy could succeed.

Another observation is that institutions matter. Precisely because creativity and entrepreneurship are unpredictable, they require a stable environment of expectations and rules of the game to thrive and prosper. In part, institutions refer to people - the presence of reliable and trustworthy people making decisions in public institutions. In part, they refer to rules. A healthy environment should include well defined systems of grants and incentives, clear rules of intellectual property, and well defined mechanisms to place the proper persons in the right places.

The final conclusion is one of cautious optimism. The current international environment for science and technology is not forgiving for traditional, self-contained, bureaucratic ways of organizing and implementing research and development, nor for self-contained adventures of technological self-sufficiency, but provide many opportunities for those with the initiative and the ability to know what is happening and find their own ways. It is true that knowledge and competence keep concentrating, but they are also increasing in quality and quantity, and because of that there might be more opportunities for small and modest initiatives today than in the past. What is needed, to make use of these opportunities, is less a matter of resources than of change of attitudes and intellectual habits. But this may be, unfortunately, the most difficult thing to do.
